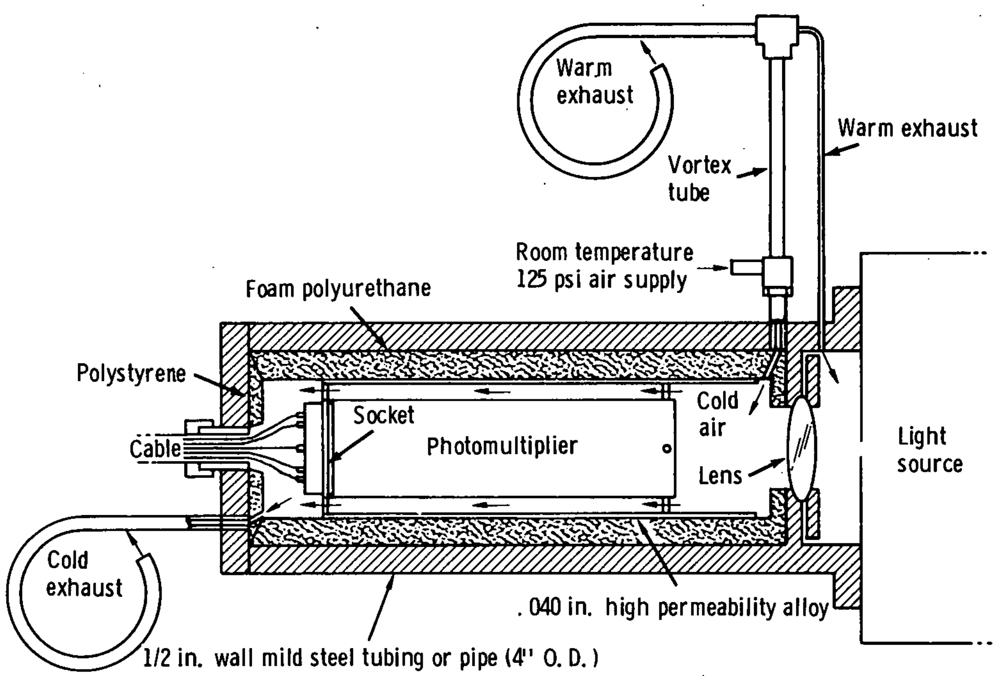
NASA TECH BRIEF

Lewis Research Center

Low-Cost, Compact, Cooled Photomultiplier Assembly for Use in Magnetic Fields Up to 1400 Gauss



Cooled photomultiplier assembly for 1400 gauss field (not to scale).

A low-cost, compact, cooled photomultiplier assembly for use in very intense steady magnetic fields has been developed. The use of a vortex tube for cooling, and concentric shielding, have produced a much smaller, more compact unit than was previously available using refrigeration cooling.

Electron temperatures in hot gas plasmas are very high ($250x10^3$ K ($450x10^3$ °F)). The only practical way to experimentally measure these temperatures is to measure the electromagnetic energy that radiates from the plasma stream itself. These measurements are made with a monochromator which contains the photomultiplier described here.

The monochromator is positioned at a viewing port of the Superconducting Magnetic Mirror Apparatus (SUMMA) enabling the photomultiplier tube to "look" at one color of light from the energetic plasma stream at a time. Photons radiating from the plasma stream strike the cathode of the photomultiplier releasing electrons. The ratio of electron activity detected by the photomultiplier at two different colors is related to the energy (and therefore temperature) levels measured.

The cross-section of the NASA-designed photomultiplier assembly is shown in the figure. The assembly is cooled by supplying dry air at $8.6x10^5$ N/m^2 (125 psig) to a commercially available vortex tube. The cold exhaust from the center of the tube flows around the end-on type photomultiplier cooling it by forced convection. The cold air is exhausted into a coiled tube that is blackened on the inside to prevent room light from entering the photomultiplier cavity. A small portion of the warm air from the periphery of the vortex tube is directed across the lens of the assembly to prevent fogging.

(continued overleaf)

Shielding is provided by concentric cylinders of high magnetic permeability alloy, polyurethane foam, and mild steel tubing or pipe. The high magnetic permeability alloy acts as an electrostatic and magnetic shield for the photomultiplier. The polyurethane acts as both a heat insulator and an electrical insulator. The mild steel provides additional magnetic shielding for the device.

Dry air at 3.8×10^{-3} m^3/sec (8 SCFM) flowing into the vortex tube maintains the photomultiplier at a temperature of 243 K (-22°F), which reduces the dark current by a factor of 39 and improves the signal-to-noise ratio of the tube significantly. The 10 cm (4 in) diameter, 1.27 cm (½ in) thick wall steel tube allows continuous operation of the tube in a 1400 gauss external magnetic field which is applied perpendicular to the centerline of the tube. The effectiveness of the magnetic shielding is demonstrated by a change in gain of the tube output of less than 2 percent when the magnetic field is applied.

Future uses of this device could include installation in gas chromatographs and mass spectrometers. Additional uses would include measurements and controls in magnetohydrodynamic power generators and fusion reactors.

Notes:

1. Further information is available in the following report:

   NASA TM-X-71635 (N75-15018), Ion and Electron Temperatures in the SUMMA Mirror Device by Emission Spectroscopy

   Copies may be obtained at cost from:

   Aerospace Research Applications Center
   Indiana University
   400 East Seventh Street
   Bloomington, Indiana 47401
   Telephone: 812-337-7833
   Reference: B75-10152

2. Specific technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B75-10152

Patent Status:

NASA has decided not to apply for a patent.

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